MEMORANDUM OF UNDERSTANDING FOR THE 2002-2003 MESON TEST BEAM PROGRAM

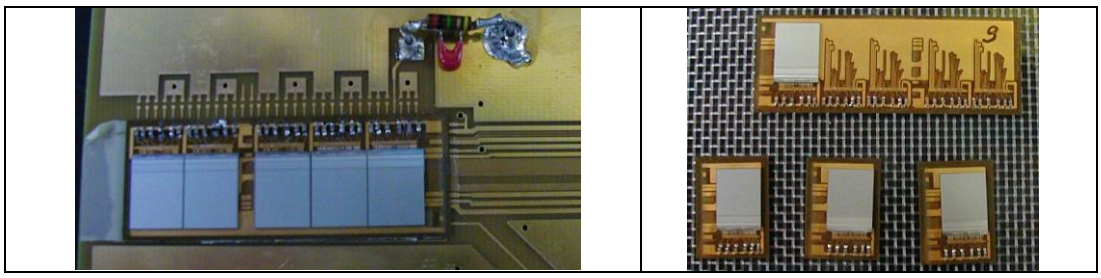
T936

The US-CMS Forward Pixel Group

June 18, 2003

INTRODUCTION

This proposal requests beam time at Fermilab during the 2003-04 Meson Test Run to test prototype silicon pixel detectors for the US-CMS forward pixel detector. The discovery of the Higgs particles at the LHC may depend on the identification of secondary vertices. This would be impossible with a Si-strip tracker with its inner layer at 20 cm from the beam line, such as the one for CMS. Pixel detectors starting at 4 cm from the beam line will identify secondary vertices. This project is funded through the US-CMS Project and through DOE and NSF Base Support. Participating institutions are FermiLab, Johns Hopkins U., Northwestern U., Purdue U., U. of C. Davis, U. of Mississippi, and Rutgers U.. This effort has recently successfully tested prototype readout chips and measured the electrical properties of pixel sensors. The bump bonding of these components is in progress at UCD and with two vendors (MCNC and IZM). We anticipate having bump bonded devices within weeks and we will then proceed to test them with radioactive sources and laser beams. The testing must then continue in a beam. The two main goals are to measure the charge collection of the pixel detectors and their position resolution, before and after irradiation. We expect the charge collection to be high and consequently will proceed with the pre- production submission of the sensors. The silicon telescope needed to define the particle's trajectory with its DAQ will be supplied by the group from Rutgers. Rutgers and Purdue have a proposal (T932-mou.doc) to test diamond detectors in the same beam line.



Above are pictures of VHDIs with readout chips that we have recently tested in the lab. Similar units with sensors read out by multiple ROCs will be tested in the beam. Below we detail what we expect to accomplish in the beam tests of the US-CMS pixel detectors as well as what resources are required.

This is a memorandum of understanding between the Fermi National Accelerator Laboratory and the US-CMS Pixel group. This test beam effort will use the silicon telescope built by our colleagues from Rutgers and utilized in test beam request T932. The same group will also supply the necessary readout electronics for the pixel detectors. This electronics exists, and it is presently being used at Rutgers, Fnal and soon at Purdue.
The memorandum is intended solely for the purpose of providing a budget estimate and a work allocation for Fermilab, the funding agencies, and the participating institutions. It reflects an arrangement that is currently satisfactory to the parties. It is recognized however, that changing circumstances of the evolving research program will necessitate revisions. The parties agree to negotiate amendments to this memorandum which will reflect such required adjustments.

I. PERSONNEL AND INSTITUTIONS:

Physicist in charge of beam tests: Steven Worm, Rutgers Univ.

Fermilab liaison: Erik Ramberg

The group members at present and others interested in the testbeam are:

1.1 FermiLab: M. Atac, S. Cihangir, U. Joshi, S. Kwan, W. Wester,

Other commitments:
BTeV and CMS: S. Cihangir, S. Kwan
CDF and CMS: W. Wester

1.1 Rutgers University: J. Doroshenko, T. Koeth, L. Parera, S. Schnetzer, R. Stone, S. Worm

Other commitments:
CDF: S. Worm
CMS: J. Doroshenko, L. Parera, S. Schnetzer, R. Stone, S. Worm
HiRes: L. Parera, S. Schnetzer

1.2 Purdue University: D. Bortoletto, I. Shipsey, G. Bolla, J. Lee, K. Arndt, A. Roy, S. Son.

Other commitments:
CDF and CMS: D. Bortoletto, G. Bolla, A. Roy
CLEO and CMS: I. Shipsey, J. Lee, K. Arndt

1.3 Johns Hopkins University: B. Barnett, D. Kim, G. Liang, M. Swartz

Other commitments:
CDF and CMS: B. Barnett

1.4 Northwestern University: B. Gobbi, M. Kubantsev, E. Spencer

1.5 University of California Davis: Richard Lander

Other commitments:
CDF and CMS: R. Lander

1.6 University of Mississippi: L. Cremaldi, D. Sanders

Other commitments:
BaBar, Auger, and CMS: L. Cremaldi

II. EXPERIMENTAL AREA, BEAMS AND SCHEDULE CONSIDERATIONS

2.1 LOCATION

2.1.1 The experiment is to take place in the MTEST beam line and located in the area designated MT6-A2. In addition, the alcove control room to the east of the MTEST line will be used to house electronics (up to two 19" racks of electronics)

2.1.2 Additional work space will be needed in this control room, equivalent to at most two 6'x3' tables. This space will be used for computing and general work space.

2.2 BEAM

2.2.2 The tests will use slow resonantly-extracted, Main Injector proton beam focused onto the MTest target. The tests require a beam of untagged, charged particles of energy approximately 80 GeV.

2.2.3 Intensity: Variable, in the range of 1-10 KHz in an area of 1 square cm. With the current beam line design this is expected to require up to 2×10^{10} primary protons per second.

2.2.4 We can make good use of the planned initial beam to MTEST. Currently this is envisioned to be a 1 sec spill per 60 sec supercycle. We anticipate some parasitic running during the test beams outlined in T927 (BTeV pixel test beam, located at MT6-A1). We would like to be informed of any accesses.

2.3 SETUP

2.3.2 At least one full day of access to the experimental area will be needed to set up the pixel test stand. This includes not only the silicon telescope planes and mechanical apparatus, but also the cable work. At least one additional day will be needed to install and debug the DAQ and NIM logic associated with the trigger. This would require only sporadic access.

2.3.3 Cabling to the counting room is significant. We have allowed one day of setup time. An outline of our cable needs between counting house and MT6-A2 include:

- Strip sensors (3 cond. for power, 20 cond. ribbon, 6 RG58 BNC coax)
- Pixel sensors (3 cond. for power, 60 cond. ribbon, 16 RG58 BNC coax)
- Trigger scintillators (5 RG59 SHV for voltage, 38 RG58 BNC coax)
- Power, Ethernet, DAQ interconnection cables (in counting house)

2.3.4 The time needed to switch setup between T932 and the US-CMS Pixel is about four hours with one hour of access time.

2.4 SCHEDULE

2.4.2 We are requesting a few days of setup time followed by three weeks of regular data taking. Each run will consist of a few hours of measurements, and we will take data with about 8 devices and possibly at several angles of incidence to the beam for each. Upon changing to a new device under test or a new angle of incidence, access to the

experimental area will be needed for a brief period (1 hour to replace detector and 15 min to change angle).

III. RESPONSIBILITIES BY INSTITUTION - NON FERMILAB

([] denotes replacement cost of existing hardware.)

3.1	US-CMS Pixel Detectors	[$120k]
3.2	Mechanical translation stage, stepper motors, computer control	[$10k]
3.3	(All equipment and DAQ will be supplied by the Rutgers University group.)	
3.3.1	VME Crate w/ 5, 2V supplies (if item 2 in Appendix I is unavailable)	[3]
3.3.2	Silicon telescope mechanical assembly	[2]
3.3.3	Silicon telescope detector planes and holders	[15]
3.3.4	Digital scope	[10]
3.3.5	Keithley 237 Voltage/Current Source	[8]
3.3.6	Pulse generator w/ adj rate knob	[2]
3.3.7	Comp. control attenuator	[1]
3.3.8	2 10V supplies 10A	[1]
3.3.9	2 PC's, monitors, Ethernet and hub	[3]
3.3.10	2 DLT drives and tapes	[2]
3.3.11	Soldering iron	[1]
3.3.12	Asst. lemo cables, voltmeters, tools, toolbox	[1]
3.3.13	60 150' BNC, SHV, lemo, and ribbon cables	[2]
3.3.14	Remote positioning system (manipulators, encoders)	[3]
3.3.15	CCD camera for monitoring	[1]
	Total existing items	[185K]

IV. RESPONSIBILITIES BY INSTITUTION - FERMILAB

([] Denotes replacement cost of existing hardware.)

4.1 Fermilab Beams Division:

4.1.1 Use of MTest beam.

4.1.2 Maintenance of all existing standard beam line elements (SWICs, loss monitors, etc) instrumentation, controls, clock distribution, and power supplies.

4.1.3 A scaler or beam counter signal should be made available in the alcove.

4.1.4 Reasonable access to our equipment in the test beam.

4.1.5 The test beam energy and beam line elements will be under the control of the BD Operations Department Main Control Room (MCR).

4.1.6 Position and focus of the beam on the experimental devices under test will be under control of MCR. Control of secondary devices that provide these functions may be

delegated to the experimenters as long as it does not violate the Shielding Assessment or provide potential for significant equipment damage.

4.1.7 The integrated effect of running this and other SY120 beams will not reduce the antiproton stacking rate by more than 5% globally, with the details of scheduling to be worked out between the experimenters and the Office of Program Planning.

4.1.S Summary of Beam Division costs:

Type of Funds	Equipment	Operating	Personnel (person-weeks)
Total new items	$0.0K	$0K	0.0

4.2 Fermilab Particle Physics Division

4.2.1 Cooling water (or a chiller) and dry nitrogen (for electronics) should be provided.

4.2.2 The test-beam efforts in this MOU will make use of the Meson Test Beam Facility. Requirements for the beam and user facilities are given in Section 2. The Fermilab Particle Physics Division will be responsible for coordinating overall activities in the MTest beam-line, including use of the user beam-line controls, readout of the beam-line detectors, and MTest gateway computer.

4.2.S Summary of Particle Physics Division costs:

Type of Funds	Equipment	Operating	Personnel (person-weeks)
Total new items	$0K	$0K	0

4.3 Fermilab Computing Division

4.3.1 Ethernet and printers should be available in the counting house.

4.3.2 Connection to beams control console and remote logging (ACNET) should be made available in the counting house.

4.3.3 See Appendix I for summary of PREP equipment pool needs.

4.4 Fermilab ES&H Section

4.4.1 Assistance with safety reviews.

V. SUMMARY OF COSTS

Source of Funds [$K]	**Equipment**	**Operating**	**Personnel** (person-weeks)
Beams Division	$0.2K	$0K	0.2
Particle Physics Division	0	0	0
Computing Division	0	0	0
Totals Fermilab	$0.2K	0	0.2
Totals Non-Fermilab	[$185K]		

VI. SPECIAL CONSIDERATIONS

6.1 The responsibilities of the L2-Manager of the US-CMS Pixel group and procedures to be followed by experimenters are found in the Fermilab publication "Procedures for Experimenters" (PFX). The Physicist in charge agrees to those responsibilities and to follow the described procedures.

6.2 To carry out the experiment a number of Environmental, Safety and Health (ES&H) reviews are necessary. This includes creating a Partial Operational Readiness Clearance document in conjunction with the standing Particle Physics Division committee. The L2-Manager of the US-CMS Pixel group will follow those procedures in a timely manner, as well as any other requirements put forth by the division's safety officer.

6.3 The L2-Manager of the US-CMS Pixel group will ensure that at least one person is present at the Meson Test Beam Facility whenever beam is delivered and that this person is knowledgeable about the experiment's hazards.

6.4 All regulations concerning radioactive sources will be followed. No radioactive sources will be carried onto the site or moved without the approval of the Fermilab ES&H section.

6.5 All items in the Fermilab Policy on Computing will be followed by experimenters.

6.6 The L2-Manager of the US-CMS Pixel group will undertake to ensure that no PREP and computing equipment be transferred from the experiment to another use except with the approval of and through the mechanism provided by the Computing Division management. They also undertake to ensure that no modifications of PREP equipment take place without the knowledge and consent of the Computing Division management.

6.7 Each institution will be responsible for maintaining and repairing both the electronics and the computing hardware supplied by them for the experiment. Any items for which the experiment requests that Fermilab performs maintenance and repair should appear explicitly in this agreement.

6.8 If the experiment brings to Fermilab on-line data acquisition or data communications equipment to be integrated with Fermilab owned equipment, early consultation with the Computing Division is advised.

6.9 At the completion of the experiment:

6.9.1 The L2-Manager of the US-CMS Pixel group is responsible for the return of all PREP equipment, Computing equipment and non-PREP data acquisition electronics. If the return is not completed after a period of one year after the end of running the L2-Manager of the US-CMS Pixel group will be required to furnish, in writing, an explanation for any non-return.

6.9.2 The experimenters agree to remove their experimental equipment as the Laboratory requests them to. They agree to remove it expeditiously and in compliance with all ES&H requirements, including those related to transportation. All the expenses and personnel for the removal will be borne by the experimenters.

6.9.3 The experimenters will assist the Fermilab Divisions and Sections with the disposition of any articles left in the offices they occupied, including computer printout and magnetic tapes.

6.9.4 An experimenter will report on the test beam effort at a Fermilab All Experimenters Meeting.

SIGNATURES:

_____ / / 2003
Steven Worm, Rutgers University

_____ / / 2003
John Cooper, Particle Physics Division

_____ / / 2003
Roger Dixon, Beams Division

_____ / / 2003
Victoria White, Computing Division

_____ / / 2003
William Griffing, ES&H Section

_____ / /2003
Hugh Montgomery, Associate Director, Fermilab

_____ / /2003
Steven Holmes, Associate Director, Fermilab

_____ / / 2003
Michael Witherell, Director, Fermilab

APPENDIX I – US-CMS PIXEL GROUP **BEAM TEST – EQUIPMENT POOL NEEDS**

The equipment listed is the same as the one requested for T932.

Equipment Pool items needed for Fermilab test beam, needed on the first day of setup:

Quantity	Description
4	Nim crates, with cooling fans
1	VME crate and power supply with CERN modified JAUX: -5,-2 Volt
1	NIM 4CH 3/8KV 3/1mA HV POWer CAEN N470 or equivalent
5	NIM Octal descriminators Lecroy 623
4	NIM logic fan in/out Lecroy 429a
2	Quad Scaler and Preset Counter CAEN N145 or equivalent
6	NIM Dual Timing unit CAEN N93B/2255B
4	NIM Tri- coincidence logic Lecroy 465
3	NIM quad-coin. logic Lecroy 622
1	TTL ←→ Nim level adapter Lecroy 688AL
2	Caen N570 dual +HV supplies or equivalent
1	pulse gen. fast risetime (<5ns) +- 20v
1	analogue or digital oscilliscope
2	adjustable (~7Volt @ >= 2 amp) DC low noise supplies for Si strips
2	adjustable (~8Volt @ >= 2 amp) DC low noise supplies (Vienna pixel)

APPENDIX II - Hazard Identification Checklist

Items for which there is anticipated need have been checked

	Cryogenics		Electrical Equipment		Hazardous/Toxic Materials
	Beam line magnets		Cryo/Electrical devices		List hazardous/toxic materials
	Analysis magnets		capacitor banks		planned for use in a beam line or experimental enclosure:
	Target	X	high voltage		
	Bubble chamber	X	exposed equipment over 50 V		
	Pressure Vessels		**Flammable Gases or Liquids**		
	inside diameter	Type:			
	operating pressure	Flow rate:			
	window material	Capacity:			
	window thickness		**Radioactive Sources**		
	Vacuum Vessels		permanent installation		**Target Materials**
	inside diameter		temporary use		Beryllium (Be)
	operating pressure	Type:			Lithium (Li)
	window material	Strength:			Mercury (Hg)
	window thickness		**Hazardous Chemicals**		Lead (Pb)
	Lasers		Cyanide plating materials		Tungsten (W)
	Permanent installation		Scintillation Oil		Uranium (U)
	Temporary installation		PCBs	X	Other : **Si**
	Calibration		Methane		**Mechanical Structures**
	Alignment		TMAE		Lifting devices
type:			TEA	X	Motion controllers
Wattage:			photographic developers		scaffolding/elevated platforms
class:			Other: Activated Water?		Others